Technical Report EL-93-12
July 1993

US Army Corps
of Engineers
Waterways Experiment
Station

An Evaluation of Stabilization/Solidification of a K088 Spent Potliner Waste

by Michael G. Channell, Teresa T. Kosson
Environmental Laboratory

Approved For Public Release; Distribution Is Unlimited

Prepared for U.S. Environmental Protection Agency

Technical Report EL-93-12
July 1993

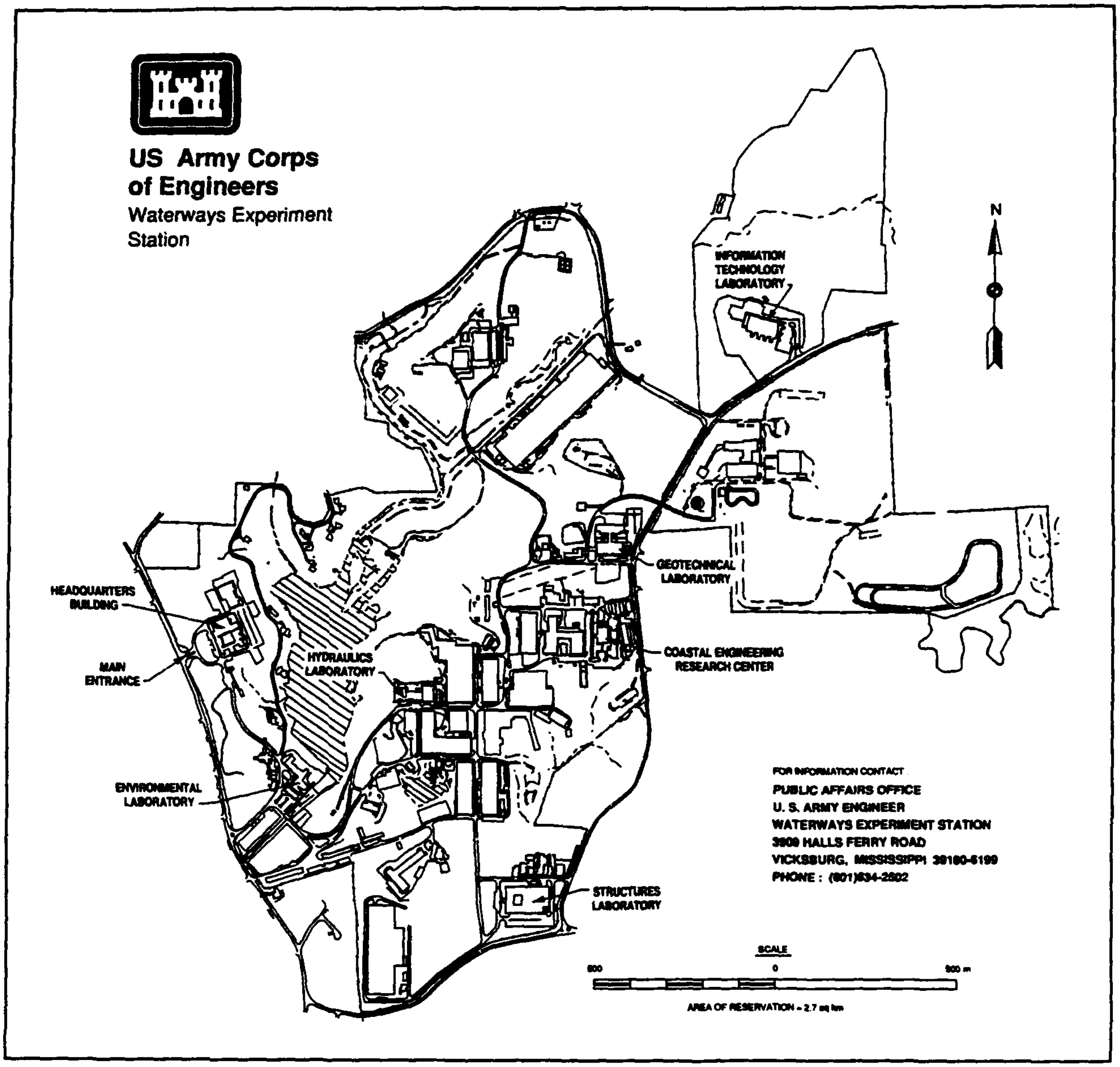
An Evaluation of Stabilization/Solidification of a K088 Spent Potliner Waste

by Michael G. Channell, Teresa T. Kosson
Environmental Laboratory

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final Report

Prepared for Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Technical Evaluation and Development Section
Cincinnati, OH 45268



Waterways Experiment Station Cataloging-in-Publication Data

Channell, Michael G.
An evaluation of stabilization/solidification of a KO88 spent potliner waste / by Michael G. Channell, Teresa T. Kosson ; prepared for Risk Reduction Engineering Laboratory, U.S. Environmental Protection Agency, Technical Evaluation and Development Section.
44 p. : ill. ; 28 cm. — (Technical report ; EL-93-12)
Includes bibliographical references.
1. Electrolytic cells — Lining — Environmental aspects. 2. Binders (Materials) 3. Smelting furnaces — Waste disposal. 4. Factory and trade waste — Leaching. I. Kosson, Teresa T. II. Risk Reduction Engineering Laboratory (U.S.) III. United States. Environmental Protection Agency. III. U.S. Army Engineer Waterways Experiment Station. IV. Title. V. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; EL-93-12.
TA7 W34 no.EL-93-12

Contents

Preface v

Conversion Factors, Non-SI to SI Units of Measurement vi

1—Introduction 1

- Background 1
- Stabilization/Solidification 2
- Waste of Interest 3
- Purpose and Scope 3
- Organization of Report 4

2—Materials and Methods 5

- General Study Approach 5
- Sample Collection 5
- Preparation of Test Specimens 6
- UCS and TCLP Testing 8

3—Discussion of Results 10

- Initial Screening Test Results 10
- UCS Results 11
- Bleed Water Results 13
- Ratios Selected for TCLP Extraction 14
- TCLP Results 14

4—Conclusions 18

References 19

Tables 1-10

Appendix A: Unconfined Compressive Strength Data A1

Appendix B: Toxicity Characteristic Leaching Procedure Data B1

Appendix C: Binder Toxicity Characteristic Leaching Procedure Results . . C1

SF 298

List of Figures

Figure 1. Schematic flowchart for stabilization processing 6

Figure 2. UCS versus curing time for the S/S KO88 spent potliner waste using different cement binder ratios 12

Figure 3. UCS versus curing time for the S/S KO88 spent potliner waste using different kiln dust binder ratios 12

Figure 4. UCS versus curing time for the S/S KO88 spent potliner waste using different lime/fly ash binder ratios 13

Figure 5. UCS versus curing time for the S/S KO88 spent potliner waste using different binder "X" binder ratios 14

Figure 6. TCLP results of cyanide for the different binders used for the S/S of the KO88 spent potliner waste 15

Figure 7. TCLP results of fluoride for the different binders used for the S/S of the KO88 spent potliner waste 16

Figure 8. Percent treatment for cyanide and fluoride based on binders used for the S/S of the KO88 spent potliner waste . . . 16

Preface

This report was prepared for the U.S. Environmental Protection Agency (USEPA), Risk Reduction Engineering Laboratory, by the U.S. Army Engineer Waterways Experiment Station (WES).

The work was performed during the period June 1991 to September 1992 by Mr. Michael Channell and Ms. Teresa Kosson, Environmental Restoration Branch (ERB), Environmental Engineering Division (EED), Environmental Laboratory (EL), WES. Chemical analyses were performed by Science Applications International Corporation, Rockville, MD. The work was conducted at WES under the direct supervision of Mr. Norman R. Francingues, Chief, ERB, and the general supervision of Dr. Raymond L. Montgomery, Chief, EED, and Dr. John Harrison, Director, EL. Project officer for the USEPA was Mr. Ron Turner.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Leonard G. Hassell, EN.

This report should be cited as follows:

> Channell, M. G., and Kosson, T. T. (1993). "An Evaluation of stabilization/solidification of a KO88 spent potliner waste," Technical Report EL-93-12, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multipy	By	To Obtain
degrees (angle)	0.01745329	radians
feet	0.3048	meters
gallons (U.S. liquid)	3.785412	liters
inches	0.0254	meters
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.4535924	kilograms
square inches	6.4516	square centimeters

1 Introduction

Background

Amendments to the Resource Conservation and Recovery Act (RCRA), enacted through the Hazardous and Solid Waste Amendments of 1984, impose substantial responsibilities on handlers of hazardous waste. In particular, these amendments prohibit the continued land disposal of untreated hazardous wastes beyond specified dates "unless the Administrator determines that the prohibition...is not required in order to protect human health and the environment for as long as the wastes remain hazardous..." (RCRA Sections 3004(d)(1), (e)(5), 42 USC 6924(D)(1), (e)(1), and (g)(5)).

Wastes treated according to treatment standards set by the U.S. Environmental Protection Agency (USEPA) under Section 3004(m) of RCRA are not subject to the prohibitions and may be land disposed. The statute requires USEPA to set "levels or methods of treatment, if any, that substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized..." (RCRA Section 3004(m)(1), and 42 USC 6924 (m)91).

To expedite the development of treatment standards, various deadlines were established for agency action. Further land disposal of a particular group of hazardous wastes is prohibited at certain deadlines if the USEPA has not set treatment standards under RCRA Section 3004(m) for such wastes or determined, based on a case-specified petition, that there will be no migration of hazardous constituents from the units for as long as the wastes remain hazardous. Additional deadlines result in conditional restrictions on land disposal to take effect if treatment standards have not been promulgated or if a petition has not been granted.

Treatment standards will be established based on Best Demonstrated Available Technology (BDAT) and developed according to RCRA Section 3004(m). USEPA (1986a) defines a technology as best, demonstrated, and available as follows:

a. Best--if several technologies are available for treating the same (or similar) waste(s), the waste-treatment method that reduces the concentration and/or the migration of contaminants most effectively is considered best.

b. Demonstrated--for a waste-treatment technology to be considered demonstrated, a full-scale facility must be known to be in operation for treating the waste.

c. Available--for a waste-treatment technology to be considered available, it must (a) not present a greater total risk than land disposal, (b) be able to be purchased or licensed from the proprietor if a technology is a proprietary or patented process, and (c) provide substantial treatment.

Stabilization/solidification (S/S) is one technology that meets the demonstrated and available criteria (USEPA 1986c). S/S of hazardous wastes has been proposed as a treatment method for substantially reducing the likelihood of contaminant migration. USEPA has initiated studies to evaluate S/S technology as a BDAT and to develop data to support the establishment of treatment standards.

Stabilization/Solidification

S/S is a process that involves the mixing of a hazardous waste with a binder material to enhance the physical and chemical properties of the waste and to chemically bind any free liquid (USEPA 1986c). Typically, the binder is a cement, pozzolan, or thermoplastic. Proprietary products may also be added. Often, the S/S process is changed to accommodate specific wastes. Since completely discussing all possible modifications to an S/S process is not possible, discussions of most S/S processes have to be related directly to generic process types. The performance observed for a specific S/S system may vary widely from its generic type, but the general characteristics of a process and its products are usually similar. Comprehensive general discussions of waste S/S processes are given in Malone and Jones (1979); Malone, Jones, Larson (1980); Iadevaia and Kitchens (1980); and USEPA (1986b).

Waste S/S systems that have potential BDAT applications include the following:

a. Lime/fly ash pozzolanic processes.

b. Pozzolan-portland cement systems.

c. Vitrification.

Lime/fly ash pozzolanic processes use the finely divided, noncrystalline silica in fly ash and the calcium in lime to produce low-strength cementation. The waste containment is produced by entrapping the waste in the pozzolan concrete matrix (microencapsulation). Metals are also usually converted to less soluble forms that further inhibit leaching.

Pozzolan-portland systems use portland cement and fly ash or other pozzolan materials to produce a type of waste/concrete composite. Contaminant migration is reduced by microencapsulation of the contaminants in the concrete matrix. The addition of soluble silicates to pozzolan-portland systems may accelerate hardening. As with lime/fly ash pozzolonic systems, metals are also converted to less soluble forms in the pozzolan-portland systems.

Vitrification is a process whereby hazardous wastes are incorporated into a molten substance utilizing very high temperatures. The process is carried out by inserting electrodes into a waste mass and passing a high current of electricity through the mass. The high temperature produces a melt; and as the melt cools, contaminants are trapped in the melt. When cooled, the melt forms a stable noncrystalline solid that resembles obsidian, a very strong glass.

Waste of Interest

The KO88 spent potliner waste that was evaluated was a bottoms ash from the incineration of wastes produced from the primary reduction of aluminum from the metal smelting industry. The waste was contaminated with metals, cyanides, and fluorides. The waste was collected in three 5-gal[1] buckets and shipped to the U.S. Army Engineer Waterways Experiment Station (WES) under chain of custody by Science Applications International Corporation (SAIC), Rockville, MD, the contractor for the Risk Reduction Engineering Laboratory (RREL). The sample was obtained from the USEPA Incineration Research Facility in El Dorado, AR. Upon receipt of the samples at WES under chain of custody, the waste was placed in a walk-in cooler at 4 °C for storage until needed for testing.

Purpose and Scope

The specific objective of the study was to determine if S/S techniques could be applied to a KO88 spent potliner waste contaminated with metals, cyanides, and fluorides to characterize the effect of S/S on that soil. The physical and chemical properties of the stabilized/solidified waste were evaluated to determine if S/S techniques substantially reduced the amount of hazardous

[1] A table of factors for converting non-SI units of measurement to SI units is presented on page vi.

contaminants in the Toxicity Characteristic Leaching Procedure (TCLP) leachates and improved the physical handling properties of the waste.

Four binder systems (cement, kiln dust, lime/fly ash, and binder "X") were used to stabilize/solidify the waste. The binder "X" was sent to WES by Mr. Ron Turner of RREL. The stabilized/solidified waste was cured, and the physical and chemical properties of the treated samples were evaluated. The unconfined compressive strength (UCS) test was used to measure physical strength, and TCLP was used to assess the leachability of the chemical contaminants from the stabilized/solidified waste.

This report presents the methods and test results from the S/S of the waste material. It is not intended to determine nor does it attempt to determine whether S/S is a BDAT for the treatment of the KO88 spent potliner waste.

Organization of Report

This report is divided into four basic parts:

a. Chapter 1 briefly describes the background for this study, introduces the concept of S/S, and states the purpose and scope of this study.

b. Chapter 2 describes the methods used for sampling, treatment, and testing of the waste materials.

c. Chapter 3 presents and discusses the results of the UCS and the TCLP of the stabilized/solidified KO88 spent potliner waste.

d. Chapter 4 presents conclusions based on the results of testing.

2 Materials and Methods

General Study Approach

This investigation was conducted in four primary phases as summarized below:

a. *Phase I: Sample Collection.* Ash was collected in three 5-gal metal buckets and shipped to WES under chain of custody by SAIC, the contractor for RREL.

b. *Phase II: Preparation of Test Specimens.* Test specimens of S/S waste were prepared. Preparation of the test specimens included an initial screening test to determine the appropriate water/binder/waste ratios for detailed evaluation.

c. *Phase III: UCS and TCLP Testing.* Strength characteristics were evaluated using the UCS test. The leachability of metals, cyanide, and fluorides were evaluated using the TCLP.

d. *Phase IV: Data Compilation.* Data from WES and USEPA contractors were compiled; the study results are discussed in this report.

Sample Collection

The KO88 spent potliner ash was a bottoms ash and was collected and shipped to WES by SAIC. Samples of the raw waste were analyzed for total composition by SAIC.

On 8 May 1991, the WES Hazardous Waste Research Center (HWRC) received three 5-gal metal buckets of ash samples under chain of custody.

To assess the variability of the sampling and treatment processes, the soil was homogenized and divided into three subsamples and treated separately. Before the testing of KO88 ash, each subsample was prepared by first grinding the sample using a mortar and pestle until the sample passed a 9.5-mm sieve. All of the grinding took place in a glove box for protection against the cyanide that was present in the sample. After the grinding was accomplished, the three buckets were homogenized by randomly combining one-third of the contents of each bucket in a 60-ℓ stainless steel bowl and mixing the waste with a Hobart mixer. The three subsamples were placed into 1-gal metal containers, designated as subsample A, B, and C, and stored in a cooler at 4 °C until needed for testing. The 1-gal buckets were used for convenience while working in the glove box.

Preparation of Test Specimens

General description of S/S evaluation process

Four S/S processes were used to stabilize/solidify the KO88 spent potliner waste and were differentiated by the type of binder material used in the process. The binders evaluated were portland cement, kiln dust, lime/fly ash, and binder "X." Compositional and chemical analysis of binders used in this study except for the binder "X," are presented in Tables 1 and 2. These binders were analyzed for contaminants usually found in waste streams. Cyanide and fluoride were not evaluated in the compositional and chemical analysis of the binders.

The S/S process involves the addition of water and binder material to the waste followed by mixing and a period of curing before evaluation of physical and chemical characteristics. A schematic flowchart of the S/S processing is shown as Figure 1.

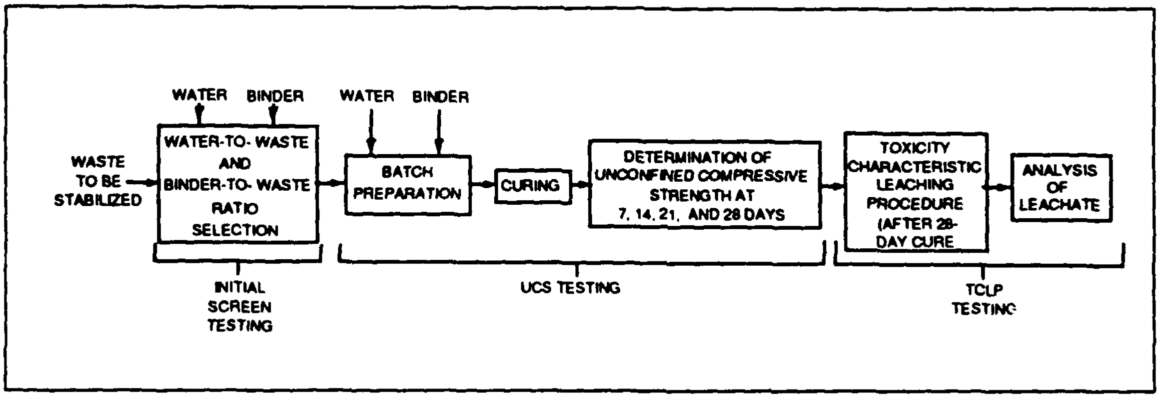


Figure 1. Schematic flowchart for stabilization processing

Initial screening test

The purpose of the initial screening test was two-fold: first, to determine the appropriate water-to-waste ratio (WWR) necessary for hydration; and second, to narrow the range of binder-to-waste ratios (BWR) used for detailed evaluation. The matrix of test specimens prepared during the initial screening test is shown in Table 3. The initial screening test involved mixing binder, water, and waste in a Hobart K455S mixer at WWRs of 0.1 and 0.2 based on the wet weight of the waste. These ratios were selected by personnel and based upon previous experience and hydration of the mixtures as samples were prepared.

Determination of the optimal BWR and WWR was based on the results of the Cone Index Test (CI). The CI was performed on the initial screening test samples after they had cured at 23 °C and 98-percent relative humidity for 48 hr. The CI measures the resistance of a material to the penetration of a 30-deg right circular cone. The method specified in TM 5-530 was followed (Headquarters, Department of the Army 1971). The CI value is reported as force per unit surface area (pounds per square inch) of the cone base required to push the cone through a test material at a rate of 72 in./min. Two cones are available for this test. The standard WES cone has an area of 0.5 sq in., and the airfield penetrometer has a base area of 0.2 sq in. It was convenient to use the standard WES cone on material with a CI less than 100 psi and to use the airfield penetrometer on materials with a CI greater than 100 psi. The maximum CI value that can be measured by the airfield penetrometer is 750 psi; therefore, materials having CI values greater than 750 psi are reported simply as >750 psi.

The results of the initial screening test define the optimal WWRs and produce data that aid in the selection of the BWRs for preparation in the detailed evaluation. The test specimens prepared during the initial screening test were not evaluated further.

Preparation of specimens for detailed evaluation

Subsamples A, B, and C were stabilized/solidified using cement, kiln dust, lime/fly ash, and binder "X." Three BWRs were evaluated for the cement, kiln dust, and binder "X" binders, and four BWRs were evaluated for the lime/fly ash.

Table 4 summarizes the matrix of test specimens prepared for the detailed evaluation. A WWR of 0.2 was used for all the batches of stabilized/solidified waste that were prepared for the cement, kiln dust, lime/fly ash, and binder "X" processes. These batches were differentiated by the alphanumeric codes shown in Table 4.

Treated specimens were prepared by mixing the soil, binder, and water in a Hobart K455S mixer. The binder/water/waste mixture was poured into 2- by

2-in. brass molds. To aid in removing UCS test specimens, a light coating of Lubriplate grease was applied to the molds. Specimens used for the TCLP test were prepared in ungreased molds. Immediately after the waste mixtures were placed in the molds, they were vibrated on a Sentron model VP61D1 vibration table to remove air voids. At the high binder ratio (0.2/0.2 lime/fly ash), some of the binder/water/waste mixtures were very viscous, and vibration was an ineffective method for removing air voids. These specimens were compacted in the 2- by 2-in. molds using a compaction hammer with a 5.74-lb weight, a 1.8- by 1.0-in. brass head and a 12-in. drop. Compaction was accomplished by placing two layers of the binder/water/waste mixture in the molds and dropping the weight five times per layer.

The molded S/S specimens were cured in the molds at 23 °C and 98-percent relative humidity for a minimum of 24 hr. During this time, the specimens were observed to determine if any free liquid formed on the surface. Specimens were removed from the molds when they developed sufficient strength to be free-standing and were cured under the same temperature and relative humidity conditions until further testing.

UCS and TCLP Testing

Unconfined Compressive Strength

UCS was used to define and characterize the effects of the S/S process on the physical strength of the S/S waste mixture. The UCS of the treated waste was determined using the American Society for Testing and Materials (ASTM) method C 109-86 (ASTM 1986). The only deviation from this method was vibration or compaction of the specimens as discussed previously.

UCS testing was performed on cubes after they had cured for 7, 14, 21, and 28 days. One cube for each batch of binder/waste mixture was tested at each curing time. The dimensions of each specimen was measured with a Fowler Max-cal caliper. The surface area was then calculated by multiplying the two measurements to obtain the area in square inches. Each cube was crushed with a Tinius Olsen Super-L compression apparatus. UCS was reported as the pounds per square inch required to fracture the cube.

Toxicity characteristic leaching procedure

Selection of BWR for leaching characteristics. For the purpose of this study, the UCS test was selected to determine the BWR for evaluation of leaching characteristics. One cube from each treatment batch was subjected to the UCS test at the completion of the 28-day cure period, as previously discussed. The stabilized BWR that produced a UCS value closest to but greater than 50 psi was the binder ratio that was selected for assessing the effects of

S/S on the contaminant-release properties of the treated soil. Because the samples deteriorated while curing in the environmental chambers, this procedure could not be followed. Based on the experience of the testing personnel, one BWR was chosen from each binder to run the TCLP. Twelve TCLP extractions representing triplicates of each BWR/WWR for each binder were performed.

Toxicity characteristic leaching procedure. The TCLP was selected by USEPA as the test protocol for evaluating chemical mobility. The TCLP was conducted using the published procedure of USEPA (1986d). TCLP extracts were collected according to the methods described by the USEPA (USEPA 1986e). The TCLP extracts were forwarded under chain of custody to the SAIC laboratory for chemical analysis.

Analytical procedures. TCLP extracts were analyzed for metals according to the methods and within the time constraints summarized in the *Federal Register* (USEPA 1986d) and specified in SW-846.

Quality assurance/quality control. The quality assurance/quality control (QA/QC) for this project was divided by the WES HWRC and SAIC. The WES HWRC was responsible for the TCLP extraction preparation and for preparation of the method blanks for each S/S waste mixture extracted. SAIC performed the chemical analysis of the TCLP extracts and internal laboratory QA/QC.

3 Discussion of Results

Initial Screening Test Results

Cement binder

The initial screening test results for the cement binder are presented in Table 5. Each value represents an average of three readings taken for each sample. The initial screening results indicate that most specimens developed a CI value greater than 750 psi after curing 48 hr. The specimen that had a BWR/WWR of 0.1/0.4 developed a CI of 163 psi after curing for 48 hr. Batch formulations of 0.05, 0.10, and 0.15 BWRs with the addition of 0.20 WWR were selected for detailed testing and evaluation.

Kiln dust binder

Results of the initial screening test for the kiln dust binder are presented in Table 6. The 0.1 BWR had a CI of >750 psi, and the 0.2 BWR had a CI of 633 psi. The 0.1 BWR/0.4 WWR did not gain any strength after 48 hr. of cure. The 0.2 BWR/0.4 WWR specimen had a CI of >750 psi. Batch formulations of 0.05, 0.10, and 0.15 BWRs with the addition of 0.2 WWR were selected for detailed testing and evaluation.

Lime/fly ash binder

Initial screening test results for the lime/fly ash binder are presented in Table 7. Test specimens that were prepared with the 0.2 WWR gained the highest strength, attaining a CI of >750 psi for all specimens. The test specimens that were prepared using a WWR of 0.4 had a CI of 725 for the 0.1/0.1 lime/fly ash and 700 for the 0.1/0.2 lime/fly ash. Based on the results, batch formulations of 0.05/0.05, 0.05/0.1, 0.1/0.05, and 0.1/0.1 lime/fly ash with a WWR of 0.2 were selected for detailed testing and evaluation.

Binder "X" binder

Initial screening test results for the binder "X" specimens are presented in Table 8. Test specimens that were prepared using a WWR of 0.2 and BWRs of 0.1 and 0.2 gained a CI of 750 psi. The samples that were prepared using a WWR of 0.4 did not gain any strength at the 48-hr cure time. Based on these results, formulations of 0.05, 0.10, and 0.15 BWR and 0.2 WWR were selected for detailed testing and evaluation.

UCS Results

The results of the UCS tests are presented as tables in Appendix A and are discussed separately for each binder system as follows.

Cement binder

Figure 2 presents a graph of the average UCS versus curing time for the treated waste when cement was used as the binder. Based upon the 28-day UCS, the UCS decreases for all the samples that were prepared. All of the samples attained a UCS greater than 200 psi for the 7-day cure time. The 0.10 specimen was the only sample that attained a UCS at 14 days of cure with a value of 139 psi. As curing time increased, the samples that were in the environmental chambers began to swell and disintegrate. The samples developed structural cracks while curing; and after samples were handled for preparation of the UCS test, they were no longer physically intact. Because of the deterioration of the samples, a UCS could not be performed.

Kiln dust binder

As indicated in Figure 3, results similar to the cement UCS data were observed when kiln dust was used as a binder. All samples developed strength at the 7-day cure. The 0.05 BWR gained the highest UCS at 349 psi. The samples developed structural cracks while curing; and after samples were handled for preparation of the UCS test, they were no longer physically intact. Because of the deterioration of the samples, a UCS could not be performed.

Lime/fly ash binder

Figure 4 presents the data for the UCS test when lime/fly ash was used as the binder. The test results for the lime/fly ash were similar to the cement and kiln dust results. The only samples to achieve any strength were the 0.05/0.05 and the 0.05/0.10 lime/fly ash specimens. These samples achieved an average UCS of 131 psi for the 0.05/0.05 BWR and 161 psi for the

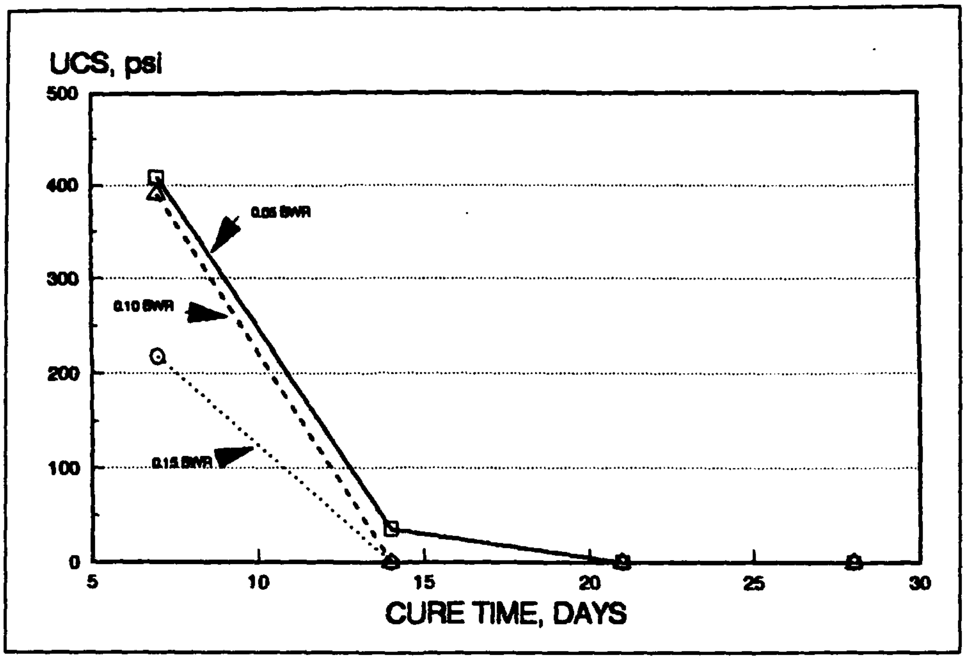


Figure 2. UCS versus curing time for the S/S KO88 spent potliner waste using different cement binder ratios

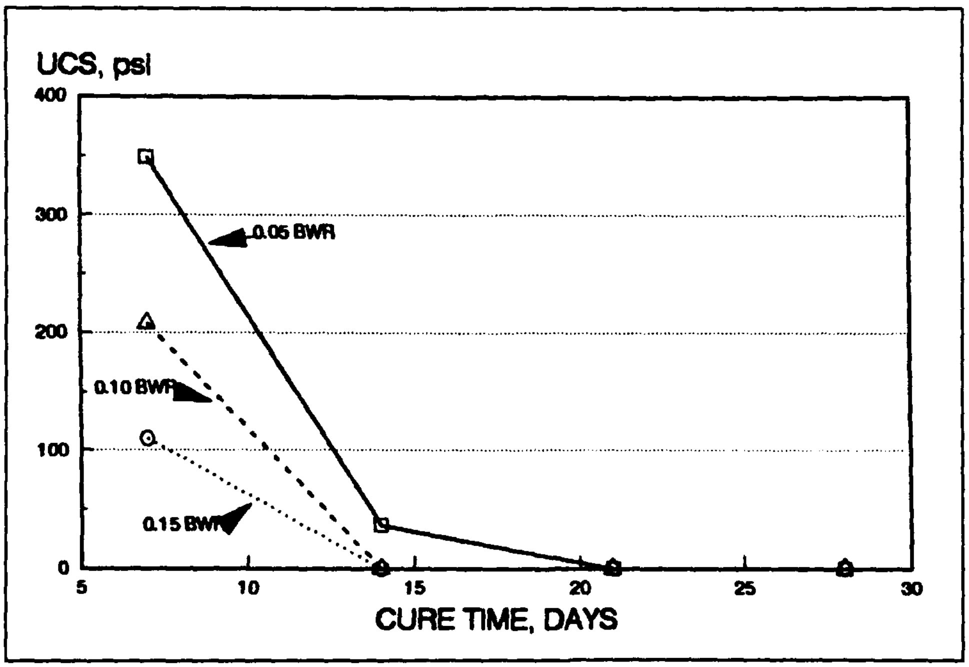


Figure 3. UCS versus curing time for the S/S KO88 spent potliner waste using different kiln dust binder ratios

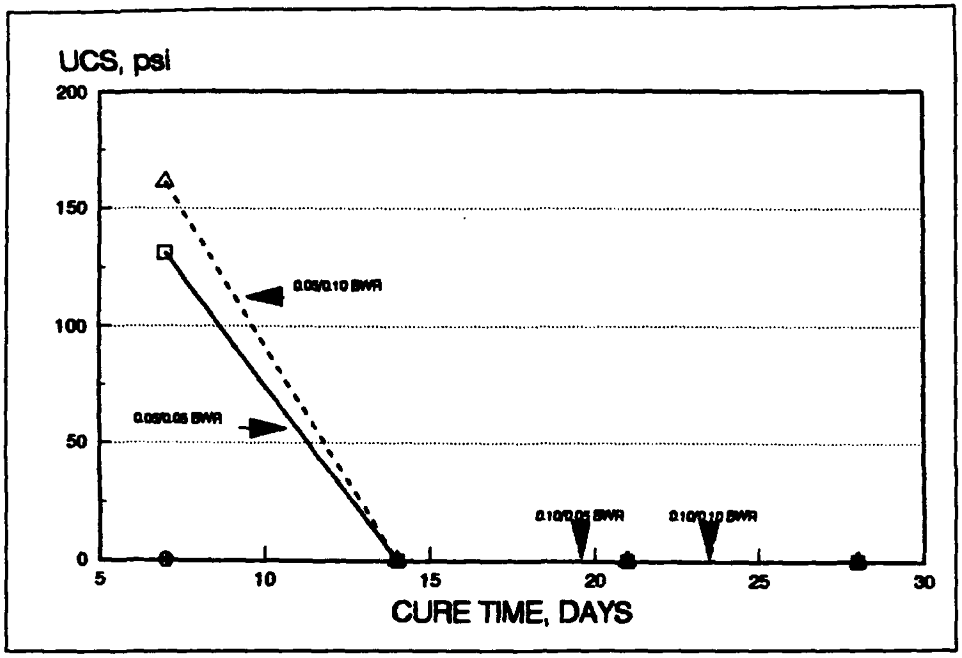


Figure 4. UCS versus curing time for the S/S KO88 spent potliner waste using different lime/fly ash binder ratios

0.05/0.1 BWR for three replicates at the 7-day cure time. The 0.2/0.1 and 0.2/0.2 lime/fly ash samples were brittle and fell apart for the 7-day cure testing. At the remaining cure times, all of the samples fell apart; and the UCS could not be run on any of the samples.

Binder "X" binder

Figure 5 presents the data from the UCS test when binder "X" was used as the binder. The only samples to develop strength during the UCS test were the 7-day samples. All of the remaining samples fell apart during the handling of the UCS test. The samples developed structural cracks during the curing and fell apart while being handled for the preparation of the UCS test.

Bleed Water Results

The samples were prepared and placed in an environmental chamber at 23 °C and 98-percent relative humidity for a minimum of 24 hr. Visual observations were conducted to determine if any of the samples leached free liquid on the surface. No samples indicated the formation of free liquid.

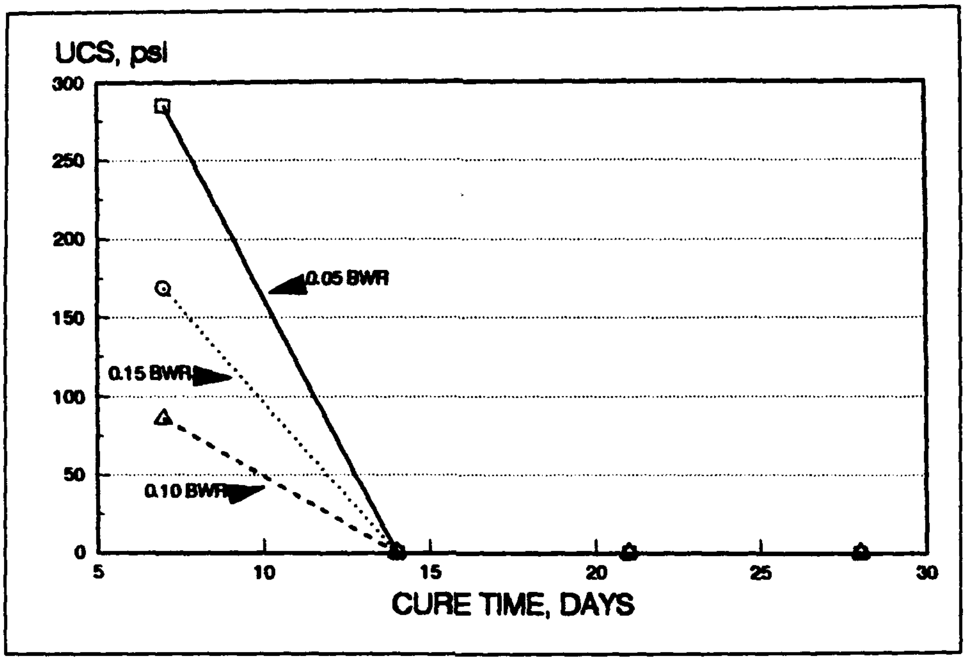


Figure 5. UCS versus curing time for the S/S KO88 spent potliner waste using different binder "X" binder ratios

Ratios Selected for TCLP Extraction

None of the samples prepared for the detailed evaluation testing of the KO88 spent potliner met the criteria of 50 psi after 28 days of cure for the UCS test. The test specimens became brittle and fell apart during handling for the UCS test. Because of this, there were no data available for the 28-day UCS test to select the sample for the TCLP evaluation. Because there were no data, the project engineer selected the binder ratios that were tested for the TCLP based on previous testing experience. Table 9 lists the ratios selected for the TCLP extraction test.

TCLP Results

The average results of the TCLP on the stabilized/solidified waste are presented in Table 10. Replicate results are presented in Appendix B. Metals, cyanides, and fluorides were the contaminants of concern for the S/S of the soil. The results of the TCLP on the binders used in this study are presented in Appendix C.

After the samples were stabilized/solidified, the TCLP was performed on the samples, and the leachates were analyzed for TCLP metals, cyanides, and fluorides. Figure 6 presents the results of the TCLP test for cyanides

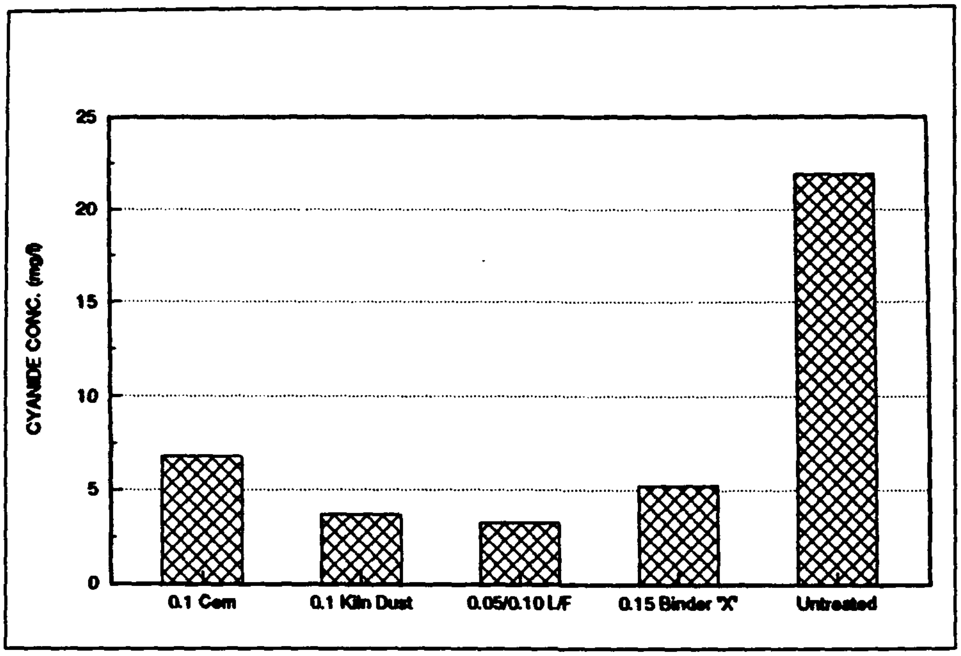


Figure 6. TCLP results of cyanide for the different binders used for the S/S of the KO88 spent potliner waste

performed on the BWRs selected for evaluation. Figure 7 presents the results of the TCLP test for fluorides performed on the BWRs selected for evaluation. The 0.1 cement BWR/0.2 WWR metals leachate analyses were less than the detection limits listed in Table 10. The cement BWR had an average concentration of 6.80 mg/ℓ and 660 mg/ℓ for cyanide and fluoride, respectively. The 0.1 kiln dust BWR/0.2 WWR metals leachate analyses were less than the detection limits listed in Table 10. The kiln dust samples had a concentration of 3.70 mg/ℓ and 896 mg/ℓ for cyanide and fluoride, respectively. The 0.05/0.1 lime/fly ash BWR/0.2 WWR metals leachate analyses were less than the detection limits listed in Table 10. The lime/fly ash samples had a concentration of 3.23 mg/ℓ and 196 mg/ℓ for cyanide and fluoride, respectively. The 0.15 binder "X" BWR/0.2 WWR metals leachate analyses were less than the detection limits listed in Table 10. The binder "X" sample had a concentration of 5.23 mg/ℓ and 826 mg/ℓ for cyanide and fluoride, respectively. The untreated sample of the KO88 spent potliner waste was subjected to the TCLP test, and the leachate was analyzed for the same constituents as the solidified/stabilized test specimens. The untreated sample did not leach any of the metals of concern during the TCLP test. The untreated sample had concentrations of 21.93 mg/ℓ and 3,733 mg/ℓ of cyanide and fluoride, respectively.

Figure 8 presents the percent treatment data for the BWRs that were subjected to the TCLP test. Percent treatment was calculated by comparing the treated waste with the untreated waste after the TCLP had been run on each of the samples. The cement specimen had a treatment efficiency of 69 percent for cyanide. The kiln dust sample had a treatment efficiency of 83 percent

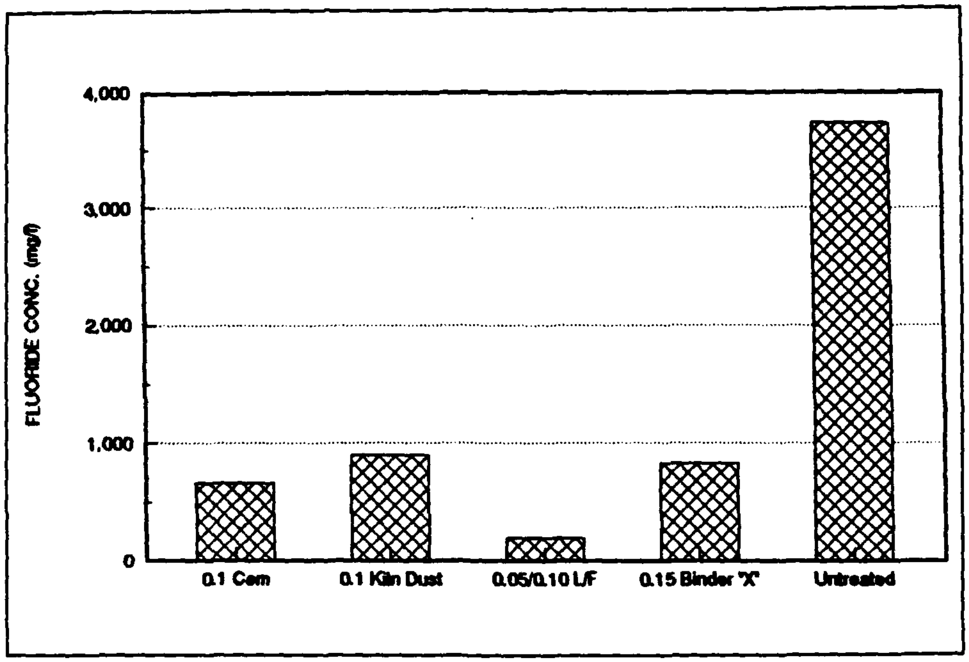


Figure 7. TCLP results of flouride for the different binders used for the S/S of the KO88 spent potliner waste

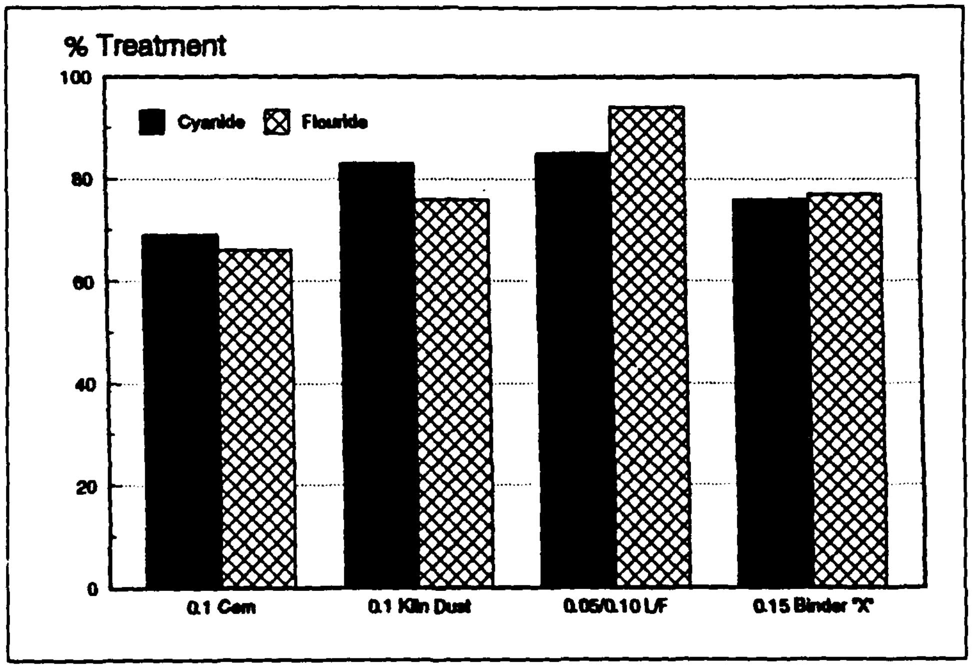


Figure 8. Percent treatment for cyanide and flouride based on binders used for the S/S of the KO88 spent potliner waste

for cyanide. The lime/fly ash sample had a treatment efficiency of 85 percent, while the binder "X" sample had a treatment efficiency of 76 percent for cyanide. For the fluoride analyte, the cement, kiln dust, and binder "X" had a treatment efficiency of 66, 76, and 77 percent, respectively. The lime/fly ash sample had the highest treatment efficiency with a value of 94 percent.

4 Conclusions

Based on the results of laboratory evaluations of the S/S techniques, the following conclusions can be made:

a. None of the binders that were selected for the detailed evaluation passed the 50-psi criteria after the 28-day cure time.

b. Water addition is required for hydration in all of the mixtures.

c. The binders can be easily mixed with the spent potliner waste.

d. The stabilized/solidified waste was not free-standing after the 7-day cure time. During handling, the samples broke apart and crumbled. This could have been due to the amount of moisture that the samples absorbed while curing in the environmental chambers.

e. The S/S process was effective in reducing the mobility of cyanide and fluoride, based on the performance of the untreated sample when subjected to the TCLP.

f. No TCLP metals of concern were detected in the leachate from the untreated and treated waste.

References

American Society for Testing and Materials. (1986). "Construction; cement; lime; gypsum." Vol 0401, *Annual bank of ASTM standards*, Philadelphia, PA.

Headquarters, Department of the Army. (1971). "Materials testing," Technical Manual No. 5-530, Section XV, Washington, DC.

Iadevaia, R., and Kitchens, J. F. (1980). "Engineering and development support of general Decon technology and the DARCOM Installation Restoration Program, Task 4," Draft Report, Atlantic Research Corporation, Alexandria, VA.

Malone, P. G., and Jones, L. W. (1979). "Survey of solidification/ stabilization and technology for hazardous industrial wastes," EPA-600/2-79-056, U.S. Environmental Protection Agency, Cincinnati, OH.

Malone, P. G., Jones, L. W., and Larson, R. J. (1980). *Guide to the disposal of chemically stabilized and solidified waste.* SW-872, Office of Water and Waste Management, U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency. (1986a). "Best demonstrated available technology (BDAT) background document for F001-F005 spent solvents," EPA 1530-SW-86-056, Vol I, Office of Solid Waste, Washington, DC.

______. (1986b). *Federal Register.* Vol 51, No. 142, Office of Solid Waste, Washington, DC.

______. (1986c). *Handbook for staoilization/solidification of hazardous wastes.* Hazardous Waste Engineering Research Laboratory, Cincinnati, OH.

______. (1986d). "Hazardous waste management system; land disposal restrictions; final rule." *Federal Register.* Part II, Vol 40 CFR Part 261 et Seq., Washington, DC.

U.S. Environmental Protection Agency. (1986e). *Test methods for evaluating solid waste: Physical/chemical methods*. SW-846, 3rd ed., Office of Solid Waste and Emergency Response, Washington, DC.

Table 1
Compositional Analyses of the Binder Materials

Compositional Analysis	Cement Type I %	Lime %	Fly ash Class F %	Kiln Dust %
SiO2	20.47	0.40	49.67	6.94
Al2O3	5.40	0.57	29.15	4.23
Fe2O3	3.58	0.16	7.11	1.47
CaO	64.77	72.27	1.26	62.93
MgO	0.87	0.65	1.43	0.44
SO3	2.73	0.02	0.23	7.01
Insoluble residue	0.17	0.24	70.70[a]	3.09
Moisture loss	0.43	0.41	0.12[b]	0.05
Loss on ignition	0.96	24.04	4.07	14.06
TiO	0.28	0.01	0.20	0.11
Mn2O3	0.06	0.00	0.00	0.00
P2O5	0.28	0.02	1.00	0.05
Total alkali				
Na2O	0.12	0.01	0.23	0.25
K2O	0.28	0.00	2.33	0.40
Na	0.05	0.004	0.10	0.10
K	0.11	0.00	0.97	0.17
Total as Na2O	0.30	0.01	1.76	0.51
Acid soluble alkali				
Na2O	0.12	0.01	0.06	0.25
K2O	0.28	0.00	0.50	0.40
Na	0.05	0.004	0.03	0.10
K	0.11	0.00	0.21	0.17
Water soluble alkali				
Na2O	0.018	0.0033	0.050	0.021
K2O	0.139	0.0220	0.105	0.050
Na	0.0075	0.0013	0.0210	0.008
K	0.0577	0.0091	0.0440	0.0208

[a] Insoluble residue includes SiO2.
[b] Free water.

Table 2
Chemical Analyses of the Binder Materials

Chemical Analysis	Cement Type I mg/kg	Kiln Dust mg/kg	Lime mg/kg	Fly Ash Class F mg/kg
Si	95,700	1,900	232,200	32,400
S (total)	10,800	700	1,700	31,200
Ti	1,400	50	1,000	600
P	900	60	3,200	200
Sb	<1.77	<1.63	<1.77	13.3
As	13.1	14.7	6.74	172
Be	2.13	4.24	<1.77	28.9
Cd	0.284	2.28	0.639	1.01
Cr	61.3	30.0	14.6	139
Cu	14.9	12.7	<0.355	196
Pb	2.13	15.6	<0.355	57.7
Hg	<0.100	<0.100	<0.100	<0.100
Ni	25.9	33.6	6.39	190
Se	<17.7	<16.3	<17.7	<19.5
Ag	<3.54	<3.54	<3.54	<3.54
Tl	<10.6	<9.78	<10.6	13.6
Zn	41.8	107	17.7	211
Al	21,100	13,500	238	150,000
Ba	178	119	<3.55	1,350
Ca	454,000	440,000	500,000	12,000
Cd	10.6	<9.78	10.6	77.2
Fe	25,400	14,800	1,070	50,700
Mg	5,460	3,040	2,700	6,040
Mn	503	64.2	48.6	156
Na	1,270	2,110	110	2,740
Sn	195	73.0	74.5	118
V	55.6	34.6	11.7	351

Table 3
Matrix of Specimens Prepared for Initial Waste/Binder Screening

Binder/Waste Ratio	Number of Specimens at Indicated Water/Waste Ratio	
	0.2	0.4
Binder: Cement		
0.1	1	1
0.2	1	1
Total = 4 specimens		
Binder: Kiln Dust		
0.1	1	1
0.2	1	1
Total = 4 specimens		
Binder: Lime, Fly Ash		
0.1, 0.1	1	1
0.1, 0.2	1	1
Total = 4 specimens		
Binder: Binder "X"		
0.1	1	1
0.2	1	1
Total = 4 specimens		

Table 4
Summary of S/S Process Batches Prepared in the Detailed Evaluation[1]

Binder-to-Waste Description		Replicates		
Code	**Ratio**	**Run 1**	**Run 2**	**Run 3**
Cement/Waste				
A	0.05	C.1.A	C.2.A	C.3.A
B	0.10	C.1.B	C.2.B	C.3.B
C	0.15	C.1.C	C.2.C	C.3.C
Kiln Dust/Waste				
D	0.05	KD.1.D	KD.2.D	KD.3.D
E	0.10	KD.1.E	KD.2.E	KD.3.E
F	0.15	KD.1.F	KD.2.F	KD.3.F
Lime/Waste, Fly Ash/Waste				
G	0.05, 0.05	L/F.1.G	L/F.2.G	L/F.3.G
H	0.05, 0.10	L/F.1.H	L/F.2.H	L/F.3.H
I	0.10, 0.05	L/F.1.I	L/F.2.I	L/F.3.I
J	0.10, 0.10	L/F.1.J	L/F.2.J	L/F.3.J
Binder "X"/Waste				
K	0.05	BX.1.K	BX.2.K	BX.3.K
L	0.10	BX.1.L	BX.2.L	BX.3.L
M	0.15	BX.1.M	BX.2.M	BX.3.M

[1] WWR = 0.2.

Table 5 Initial Screening Test Results: Cement Binder		
Cement Ratio	Water Ratio	48-hr Cone Index Value, psi
0.1	0.2	>750
0.1	0.4	163
0.2	0.2	>750
0.2	0.4	>750

Table 6 Initial Screening Test Results: Kiln Dust Binder		
Kiln Dust Ratio	Water Ratio	48-hr Cone Index Value, psi
0.1	0.2	>750
0.1	0.4	0
0.2	0.2	633
0.2	0.4	>750

Table 7 Initial Screening Test Results: Lime/Fly Ash Binder			
Lime Ratio	Fly Ash Ratio	Water Ratio	48-hr Cone Index Value, psi
0.01	0.1	0.2	>750
0.1	0.1	0.4	725
0.1	0.2	0.2	>750
0.1	0.2	0.4	700

Table 8 Initial Screening Test Results: Binder "X" Binder		
Binder "X" Ratio	Water Ratio	48-hr Cone Index Value, psi
0.1	0.2	>750
0.1	0.4	0
0.2	0.2	>750
0.2	0.4	0

Table 9 Binder Ratios Selected for TCLP Extraction		
Binder	**BWR Selected**	**Water Ratio**
Cement	0.1	0.2
Kiln dust	0.1	0.2
Lime/fly ash	0.05/0.1	0.2
Binder "X"	0.15	0.2

Table 10
Average[1] TCLP Extract Concentrations for the S/S KO88 Spent Potliner Waste

		Concentration (mg/l) Binder System/BWR/WWR			
Contaminant	**Untreated**	**Cement 0.1 BWR 0.2 WWR**	**Kiln Dust 0.1 BWR 0.2 WWR**	**Lime/Fly Ash 0.05/0.1 BWR 0.2 WWR**	**Binder "X" 0.15 BWR 0.2 WWR**
Arsenic	<1.0	<1.0	<1.0	<1.0	<1.0
Barium	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Nickel	<0.5	<0.5	<0.5	<0.5	<0.5
Selenium	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	<0.25	<0.25	<0.25	<0.25	<0.25
Cyanide	21.9	6.8	3.7	3.23	5.23
Fluoride	3,733	660	896	196	826

[1] Average of replicates A, B, and C.

Appendix A Unconfined Compressive Strength Data

This appendix contains the results of the unconfined compressive strength (UCS) testing. The UCS for each cube prepared during this evaluation is provided. Table A1 presents the UCS results for the KO88 spent potliner S/S with cement; Table A2 presents the UCS results for the KO88 spent potliner S/S with kiln dust; Table A3 presents the UCS results for the KO88 spent potliner S/S with lime/fly ash; Table A4 presents the UCS results for the KO88 spent potliner S/S with binder "X."

Table A1
UCS Results for the KO88 Spent Potliner Waste Cement Binder

Cement Ratio	Subsample ID	Cure Time, days	UCS, psi
0.05	A	7	504
	B	7	190
	C	7	530
0.05	A	14	NA
	B	14	NA
	C	14	108
0.05	A	21	NA
	B	21	NA
	C	21	NA
0.05	A	28	NA
	B	28	NA
	C	28	NA
0.10	A	7	310
	B	7	160
	C	7	700
0.10	A	14	NA
	B	14	139
	C	14	279
0.10	A	21	NA
	B	21	NA
	C	21	NA
0.10	A	28	NA
	B	28	NA
	C	28	NA
0.15	A	7	160
	B	7	171
	C	7	323
0.15	A	14	NA
	B	14	NA
	C	14	NA
0.15	A	21	NA
	B	21	NA
	C	21	NA
0.15	A	28	NA
	B	28	NA
	C	28	NA

Table A2 Raw UCS Results for the KO88 Spent Potliner Kiln Dust Binder			
Kiln Dust Ratio	Subsample ID	Cure Time, days	UCS, psi
0.05	A	7	346
	B	7	387
	C	7	315
0.05	A	14	NA
	B	14	111
	C	14	NA
0.05	A	21	NA
	B	21	NA
	C	21	NA
0.05	A	28	NA
	B	28	NA
	C	28	NA
0.10	A	7	49
	B	7	379
	C	7	196
0.10	A	14	NA
	B	14	NA
	C	14	NA
0.10	A	21	NA
	B	21	NA
	C	21	NA
0.10	A	28	NA
	B	28	NA
	C	28	NA
0.15	A	7	31
	B	7	210
	C	7	91
0.15	A	14	NA
	B	14	NA
	C	14	NA
0.15	A	21	NA
	B	21	NA
	C	21	NA
0.15	A	28	NA
	B	28	NA
	C	28	NA

Table A3
Raw UCS Results for the KO88 Spent Potliner Lime/Fly Ash Binder

Lime Ratio	Fly Ash Ratio	Subsample ID	Cure Time days	UCS, psi
0.05	0.05	A	7	164
		B	7	229
		C	7	NA
0.05	0.05	A	14	NA
		B	14	NA
		C	14	NA
0.05	0.05	A	21	NA
		B	21	NA
		C	21	NA
0.05	0.05	A	28	NA
		B	28	NA
		C	28	NA
0.05	0.10	A	7	NA
		B	7	345
		C	7	139
0.05	0.10	A	14	NA
		B	14	NA
		C	14	NA
0.05	0.10	A	21	NA
		B	21	NA
		C	21	NA
0.05	0.10	A	28	NA
		B	28	NA
		C	28	NA
0.10	0.05	A	7	NA
		B	7	NA
		C	7	NA
0.10	0.05	A	14	NA
		B	14	NA
		C	14	NA
0.10	0.05	A	21	NA
		B	21	NA
		C	21	NA

(Continued)

Table A3 (Concluded)				
Lime Ratio	Fly Ash Ratio	Subsample ID	Cure Time days	UCS, psi
0.10	0.05	A	28	NA
		B	28	NA
		C	28	NA
0.10	0.10	A	7	NA
		B	7	NA
		C	7	NA
0.10	0.10	A	14	NA
		B	14	NA
		C	14	NA
0.10	0.10	A	21	NA
		B	21	NA
		C	21	NA
0.10	0.10	A	28	NA
		B	28	NA
		C	28	NA

Table A4
Raw UCS data for the KO88 Spent Potliner Binder "X" Binder

Binder "X" Ratio	Subsample ID	Cure Time, days	UCS, psi
0.05	A	7	338
	B	7	56
	C	7	463
0.05	A	14	NA
	B	14	NA
	C	14	NA
0.05	A	21	NA
	B	21	NA
	C	21	NA
0.05	A	28	NA
	B	28	NA
	C	28	NA
0.10	A	7	NA
	B	7	NA
	C	7	259
0.10	A	14	NA
	B	14	NA
	C	14	NA
0.10	A	21	NA
	B	21	NA
	C	21	NA
0.10	A	28	NA
	B	28	NA
	C	28	NA
0.15	A	7	348
	B	7	84
	C	7	77
0.15	A	14	NA
	B	14	NA
	C	14	NA
0.15	A	21	NA
	B	21	NA
	C	21	NA
0.15	A	28	NA
	B	28	NA
	C	28	NA

Appendix B Toxicity Characteristic Leaching Procedure Data

This appendix contains the results of the chemical analyses of the Toxicity Characteristic Leaching Procedure (TCLP) extracts.

Table B1
TCLP Leachate Concentrations for the S/S KO88 Spent Potliner Waste

Binder	Sample	TCLP Concentration, mg/ℓ										
		Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Nickel	Selenium	Silver	Cyanide	Fluoride
Cement	A	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	3.9	680
	B	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	7.4	580
	C	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	9.1	720
Kiln Dust	A	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	5.6	1,900
	B	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	4.5	9.4
	C	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	1.0	780
Lime/Fly Ash	A	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	4.7	160
	B	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	2.5	220
	C	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	2.5	210
Binder "X"	A	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	3.7	880
	B	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	4.8	830
	C	<1.0	<1.0	<0.05	<0.5	<0.5	<0.0005	<0.5	<0.4	<0.25	7.2	770

Appendix C
Binder Toxicity Characteristic Leaching Procedure Results

This appendix presents the analyses of the Toxicity Characteristic Leaching Procedure (TCLP) performed on the binders utilized to stabilize/solidify the KO88 spent potliner wastes. The results for the triplicate analyses of the binders (cement, kiln dust, and lime/fly ash) are given in Table C1.

Table C1
Binder TCLP Leachate Concentrations

Binder	Sample	TCLP Concentration, mg/ℓ										
		Ag	At	Al	As	Cd	Cr	Cu	Hg	Ni	Pb	Se
Cement	A	0.035	<0.005	0.599	<0.005	0.0001	0.334	0.001	<0.0004	0.002	0.006	<0.050
	B	0.039	<0.005	0.702	0.006	<0.0001	0.307	0.001	<0.0004	0.002	0.002	<0.050
	C	0.037	<0.005	0.596	0.005	0.0001	0.300	0.001	<0.0004	<0.001	0.002	<0.050
Average		0.037	<0.005	0.632	0.004	0.0001	0.314	0.001	<0.0004	0.0015	0.002	<0.050
Kiln Dust	A	<0.010	<0.005	0.642	0.008	0.001	0.060	0.001	<0.0008	0.002	0.032	<0.050
	B	<0.010	<0.005	0.619	0.005	<0.0001	0.057	0.001	<0.0004	0.002	0.038	<0.050
	C	0.013	0.005	0.615	0.007	0.0001	0.057	0.001	<0.0004	0.004	0.044	<0.050
Average		0.008	<0.005	0.625	0.0066	0.0004	0.058	0.001	<0.0004	0.0026	0.038	<0.050
L/F[1]	A	<0.010	<0.005	0.716	0.014	0.0002	0.033	0.003	<0.0004	0.002	0.008	<0.050
	B	<0.010	<0.005	0.654	0.020	<0.0001	0.024	0.008	<0.0004	<0.001	0.006	<0.050
	C	0.019	<0.005	0.515	0.008	0.0001	0.022	0.006	<0.0004	<0.001	0.006	<0.050
Average		0.010	<0.005	0.628	0.014	0.0001	0.026	0.0056	<0.0004	0.001	0.007	<0.050

[1] L/F = Lime/Fly Ash.

(Continued)

Table C1 (Concluded)

Binder	Sample	TCLP Concentration, mg/ℓ										
		Th	Zn	Tn	Ba	Ca	Cd	Fe	Mg	Mn	Na	Va
Cement	A	0.031	<0.030	<0.200	1.06	3,340	<0.030	0.134	<0.030	0.095	12.8	<0.005
	B	<0.030	<0.030	<0.200	1.09	3,310	<0.030	0.144	0.059	0.098	12.6	<0.005
	C	<0.030	<0.030	<0.200	0.906	3,370	<0.030	0.071	0.030	0.095	12.6	<0.005
Average		0.011	<0.030	<0.200	1.019	3,340	<0.030	0.166	0.030	0.096	12.67	<0.005
Kiln Dust	A	<0.030	0.093	<0.200	0.549	3,160	<0.030	0.098	0.055	0.096	22.2	<0.030
	B	0.034	0.037	<0.200	0.613	3,160	<0.030	0.087	0.047	0.099	22.8	<0.005
	C	<0.030	0.036	<0.200	0.698	3,260	<0.030	0.078	0.069	0.103	22.9	<0.005
Average		0.012	0.055	<0.200	0.620	3,193	<0.030	0.088	0.057	0.099	22.6	<0.0006
L/F[1]	A	<0.030	0.040	<0.200	2.17	2,820	<0.030	0.054	<0.030	0.077	6.06	<0.030
	B	<0.030	0.036	<0.200	2.13	2,630	<0.030	0.089	<0.030	0.077	6.50	<0.030
	C	<0.030	0.100	0.200	2.36	2,500	<0.030	0.064	<0.030	0.070	6.88	<0.030
Average		<0.030	0.029	<0.200	2.22	2,650	<0.030	0.069	<0.030	0.077	6.48	<0.030

[1] L/F = Lime/Fly Ash.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
July 1993

3. REPORT TYPE AND DATES COVERED
Final report

4. TITLE AND SUBTITLE
An Evaluation of Stabilization/Solidification of a KO88 Spent Potliner Waste

5. FUNDING NUMBERS

6. AUTHOR(S)
Michael G. Channell
Teresa T. Kosson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199

8. PERFORMING ORGANIZATION REPORT NUMBER
Technical Report EL-93-12

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Technical Evaluation and Development Section
Cincinnati, OH 45268

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report presents the results of testing performed on a stabilized/solidified (S/S) spent potliner waste. The waste is an ash from the incineration of wastes produced from the primary reduction of aluminum from the smelting industry. The contaminants found in the waste area metals, cyanides, and fluorides. Four S/S processes were evaluated in this study. They include the following: (a) a cement process, (b) a kiln dust process, (c) a lime/fly ash process, and (d) a proprietary binder furnished by the Risk Reduction Engineering Laboratory. Physical and leaching characteristics of the S/S waste were evaluated. Physical characteristics were evaluated using the unconfined compressive strength test. The waste-leaching characteristics were evaluated using the toxicity characteristic leaching procedure. Physical test results showed that S/S waste did not produce any 28-day strengths. Results of the chemical tests showed that cyanides and fluorides were reduced in the extract of the leaching tests.

14. SUBJECT TERMS
Contaminant immobilization
Hazardous waste
Potliner waste
Solidification
Waste disposal

15. NUMBER OF PAGES
44

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		